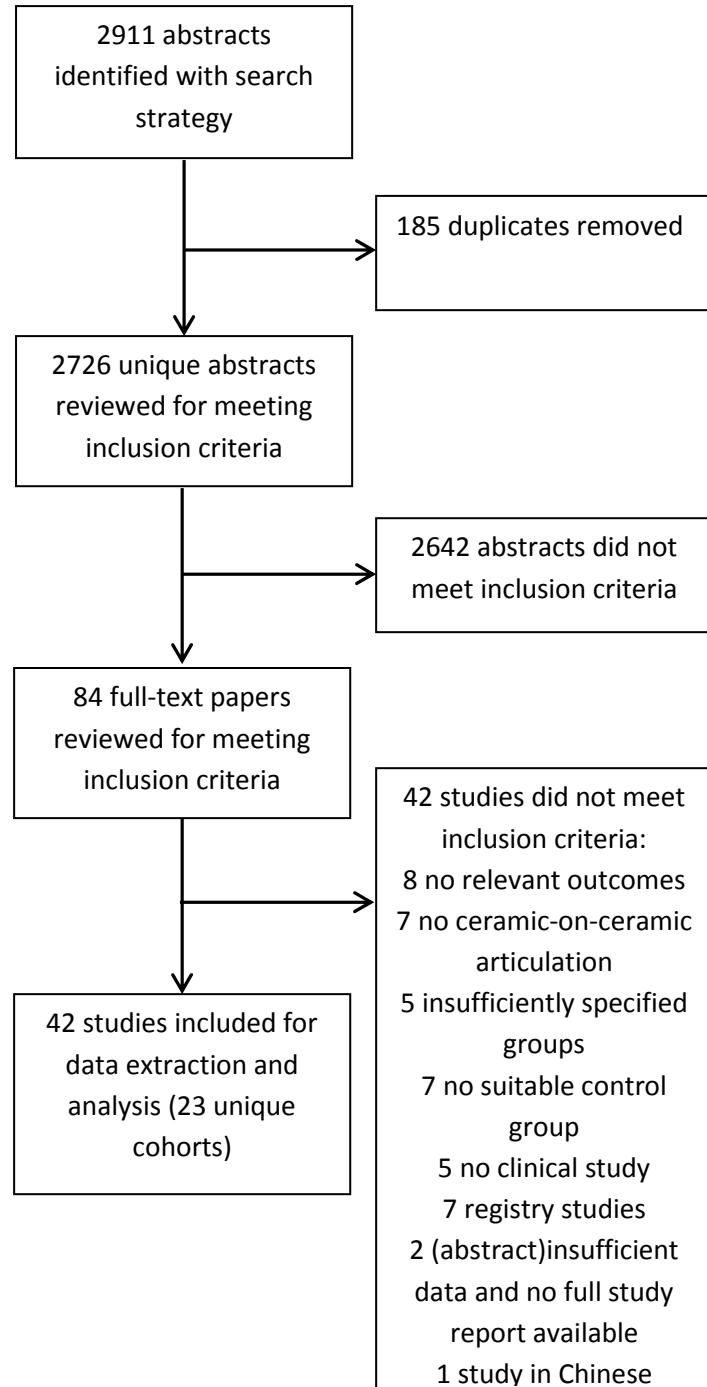


Appendix 2: Ceramic-on-ceramic bearings in total hip replacement (THR)

- Flow diagram of included studies
- Study details 1 (aspects of internal validity)
- Study details 2 (aspects of external validity)
- Study reported outcomes
- Forest plot
- References



Study details I (aspects of internal validity)											
Study	Study design	Allocation method and concealment	Outcome blinding (surgeons/ patients/ assessors)	Prospective data collection and evaluation purpose	Sample size needs clearly defined (yes/no)	Primary Outcome specified?	Intention -to-treat analysis? (yes/no)	Consecutive patients series? (yes/no)	Group comparability assessed?	Controlling for confounding?	Procedure period
Amanatullah, 2011	Randomized controlled trial	Randomized using sealed envelopes	Radiographic assessor only	Yes	No	Unclear	Unclear	Unclear	Demographics only	Randomized design, no statistical correction for between group age difference	1999 - 2001
Bal, 2005	Randomized controlled trial	Unclear randomization procedure, allocation by shipment	Unclear	Yes	No	Unclear (post-operative complications)	Unclear	Unclear	Demographics only	Randomized design, no statistical correction for between group age difference	January 1998 – January 2001
Bascarevic, 2010	Randomized controlled trial	Randomized using random number table, concealment unclear	Unclear	Yes	Yes, but power 70%	Unclear (post-operative complications)	Unclear	Unclear	Demographics and preoperative assessments	Randomized design, no statistical correction for diagnosis	January 2003 – April 2008
Beaupre, 2013	Randomized controlled trial	Block randomized using computer generated sequence in opaque envelopes opened prior to surgery	Assessor only	Yes	Yes	Yes	Yes	Unclear	Demographics and preoperative assessments	Randomized design	1998 – 2003
Cai, 2012	Randomized controlled trial	Randomized by 'receiving random number', sealed	Unclear	Yes	No	No	Unclear	Unclear	Demographics and preoperative	Randomized design assessments	April – December 2008

		envelope opened before incision								assessments		
Capello, 2005, 2008, D'Antonio, 2005, 2012, Johansson 2011	Randomized controlled trial	Unclear randomization procedure, unclear concealment	Unclear	Yes	No	No	Unclear	Unclear	Demographics and preoperative assessments	Randomized design	October 1996 – October 1998	
Capello, 2005, 2008, Johansson, 2011	Prospective comparison of successive consecutive cohorts	Time period	No	Prospective data collection	No	No	Unclear	Intervention group only	Demographics and preoperative assessments	No	October 1996 – september 2000	
Epinette, 2014	Retrospective comparison of non-consecutive, non-successive cohorts	Time period and surgeon's preference	Unclear	Unclear	No	Yes, 'wear-related complications'	NA	Yes	Demographics and preoperative assessments	No	June 1999 – september 2002	
Hamilton, 2010	Randomized controlled trial	Block randomized using computer generated sequence in consecutively numbered pull tabs	Unclear	Yes	Yes	Yes	No	Unclear	Demographics and preoperative assessments	Randomized design	2003 - NA	
Hernigou, 2013	Retrospective comparison in non-consecutive cohort with bilateral THR	NA	NA	Prospective data collection	No	Yes	NA	Unclear	No	Patients served as their own control	1978 - 1985	
Kim, 2009, 2013	Randomized controlled trial in patients with	Randomization of unclear unit using random number table, conceal-	Unclear	Yes	Yes	Yes	Unclear	Yes	Demographics NA, preoperative assessments	Randomized design and patients served as	January 2000 – January 2002	

	bilateral THR	ment unclear								their own control	
Lewis, 2010	Randomized controlled trial	Unclear randomization procedure, concealment using sealed envelopes opened before after anesthetic induction	Patients	Yes	No	No	Unclear	Unclear	Demographics and preoperative assessments	Randomized design	October 1997 – October 1999
Lombardi, 2010	Pilot cohort + randomized controlled trial	Block randomized using computer generated sequence , concealment unclear	Unclear	Yes	Yes	Yes	Unclear	Unclear	Demographics and preoperative assessments	Partially randomized design	June 2000 - NA
Milosev, 2012, Topolev, 2014	Retrospective comparison in consecutive cohort	Surgeon's preference	No	No	No	Yes	NA	Yes	Demographics and preoperative assessments	No, despite baseline differences (age, sex, diagnosis)	January 1997 - December 2007
Nikolaou, 2012	Randomized controlled trial	Block randomized using computer generated sequence in opaque envelopes opened on day of surgery	Patients and clinical outcome assessors	Yes	No	No	Unclear	Unclear	Demographics and preoperative assessments	Randomized design	February 2003 – March 2005
Ochs, 2007	Randomized controlled trial	Randomized using unclear procedure, sealed envelopes opened in operating theater	Unclear	Yes	No	Unclear	Yes	Unclear	Demographics only	Randomized design	1997 – 1999
Plate, 2013	Retrospective comparison of matched	Unclear	No	Prospective data collection	No	Yes	NA	No	Demographics and preoperative	Matching (age, sex, BMI,	2006 - 2007

	cohorts								assessments	activity)	
Poggie, 2007	Randomized controlled trial	Randomized using unclear procedure, concealment unclear	Unclear	Yes	No	No	Unclear	Unclear	Demographics and preoperative assessments	Randomized design	October 1999 – January 2003
Schmidt, 2002	Retrospect- ive matched pair analysis	NA	No	No	No	Unclear	NA	Yes (for ceramic- on- ceramic group)	Demographics and preoperative assessments	Matched for age, sex, body mass index, activi- ty level, bone stock	March 1995 – June 1996
Schwammlein 2002, Pitto 2000, 2003, Orec 2005	Randomized controlled trial	Randomized using unclear procedure, concealment unclear	Unclear	Yes	No	Yes, cup migration	Unclear	Unclear	No	Randomized design	NA
Vendittoli, 2005, 2007, 2013	Randomized controlled trial	Randomized using computer generated table, assignment revealed in operating room by research nurse	Patients until 1 year after surgery	Yes	No	Unclear	Yes	Unclear	Demographics and preoperative assessments	Randomized design	1996 – 2001
Zerahn, 2011	Randomized controlled trial	Randomized using computer generated seq- quence in closed envelopes opened prior to surgery. How- ever, exclusion after random- ization based on surgeon's preference	None	Yes	No	Yes, bone mineral density	No	No	Demographics and preoperative assessments	(Intended) randomized design, no statistical correction for between group differences	January 2001 – January 2003
Zhou,	Randomized	Randomization	Unclear	Yes	No	Yes, cup	Unclear	Unclear	Demographics	Randomized	2001 -

2006	controlled trial	procedure and concealment of allocation unclear	migration	and preoperative assessments	design	2002
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Study	Study details II (aspects of external validity)											
	No. Of replacements (no. of patients)	Mean age (SD, range)	Female (%)	Osteo-arthritis (%)	Mean length of FU (yrs; SD, range)	Follow-up completion (%)	Prosthesis brand and articulation material (specified as liner-on-head and ceramic-on-ceramic vs reference)	Manufacturer	Site, surgeon	Hospital setting (designer/university/general)	Continent (country)	
Amanatullah, 2011	357 (312)	52.3 (13.0)	39.1	NA	5 (NA)	61.6	Reflection cup with Al-on-Al versus UHMWPE-on-Al	Smith & Nephew	Multiple sites, multiple surgeons	University and general	North America (U.S.)	
Bal, 2005	500 (479)	60.0 (14, 17-94)	49.0	68.6	NA (2 – NA)	88.8	Unspecified cup with Al-on-Al versus unspecified PE-on-Al	CeramTec AG, Encore Medical	Multiple sites, multiple surgeons	University and general	North America (U.S.)	
Bascarevic, 2010	157 (150)	54.8 (6.8)	74	72	4.2 (2.8- 5.3)	NA	Trilogy cup Al-on-Al versus HXLPE-on-CoCr	Zimmer	Single site, multiple surgeons	University	Europe (Serbia)	
Beaupre, 2013	92 (92)	52.4 (6.8)	46	100	5.0 (NA)	85	Secure-fit HA Al-on-Al versus Secure fit HXLPE-on-Al	Stryker	Multiple sites, multiple surgeons	University and general	North America (Canada)	
Cai, 2012	113 (93)	42.1 (10.6)	55.9	21	3.3 (3-5)	NA	Beta cup with Al-on-Al (Biolox Delta) versus TOP UHMW PE-on Al	Link	Single site, single surgeon	University	Asia (China)	
Capello, 2005, 2008, D'Antonio, 2005, 2012, Johansson 2011 *	289 (278)	53 (10.8)	36	82	10.3 (10- NA)	82.4	Microstructured/Secur-fit cup with Al-on-Al versus unspecified PE-on-CoCr	Stryker	Multiple sites, multiple surgeons	University and general	North America (U.S.)	
Capello, 2005, 2008, Johansson, 2011 *	281 (167)	52.5 (NA)	36	81	6.5 (5 – NA)	NA	Trident cup (sandwich titanium sleeve) Al-on-Al versus unspecified PE-on-CoCr	Stryker	Multiple sites, multiple surgeons	University and general	North America (U.S.)	
Epinette, 2014	675 (628)	68.3 (9.8)	67	100	10.9 (10- 12)	41.9	Trident HA cup Al-on-Al (Biolox Forte) versus HXLPE-on-Al	Ceramtec	Single site, single surgeon	General	Europe (France)	
Hamilton,	265 (264)	56.7	48	88	2.6 (1.8-	88.3	Pinnacle cup with Al-on-Al	Ceramtec	Multiple sites,	Designer,	North	

2010	(20-75)					4.1)		(Biolox delta) versus moderately crosslinked PE-on-Al (Biolox delta)	and DePuy	multiple surgeons	university and general	America (Canada and U.S.)
Hernigou, 2013	252 (126)	45 (29-60)	44.4	0 (all FHN)		32 (30-34)	66.7	Unspecified cup with Al-on-Al versus unspecified PE-on-Al	Ceraver Osteal	Single site, NA	University	Europe (France)
Kim, 2009, 2013	210 (105)	45.3 (21-49)	34	13		12.4 (11-13)	95.2	Duraloc cup Al-on-Al (Biolox forte) versus HXLPE-on-Al	Ceramtec and DePuy	Single site, single surgeon	University	Asia (South Korea)
Lewis, 2010	56 (55)	42.1 (8.0, 19-56)	49	41		8.0 (1-10)	NA	Wright cup with Al-on-Al versus UHMWPE-on-Al	Wright Medical	Single site, multiple surgeons	General	North America (Canada)
Lombardi, 2010	110 (109)	58.2 (33-79)	56	84		6.1 (2.2-9.0)	100	Ringloc cup (sandwich PE and Biolox forte) Al-on-Al versus HXLPE-on-Zi	Biomet Inc.	Single site, single surgeon	University	North America (U.S.)
Milosev, 2012, Topolev, 2014	886 (828)	65 (36-84)	67	83		10.6 (4.1-15.0)	64	BICON PLUS (sandwich PE and Biolox forte) Al-on-Al versus UHMWPE-on-CoCr	Ceramtec and Quadrant	Single site, multiple surgeons	General	Europe (Slovenia)
Nikolaou, 2012	102 (91)	72.7 (19-64)	48	66	5 (NA)	95.1	Reflection cup with unspecified ceramic-on-ceramic versus UHMWPE (36 THRs)/ HXLPE(32 THRs)-on-CoCr	Smith & Nephew	Single site, multiple surgeons	University	North America (Canada)	
Ochs, 2007	66 (66)	58.7 (7.7)	21	53	8.1 (7.1-9.2)	65.2	Plasma cup with unspecified ceramic-on-Al (Biolox forte) versus unspecified PE-on-Al (Biolox forte)	Braun-Aesculap, CeramTec	Single site, multiple surgeons	University and general	Europe (Germany)	
Plate, 2012	60 (60)	52.5 (37-79)	63	90	3.3 (2-5)	100	Trident cup with Al-on-Al versus unspecified PE-on-unspecified metal	Stryker	Single site, single surgeon	University	North America (U.S.)	
Poggie, 2007	472 (429)	54 (12, 23-76)	45	77	NA (2-NA)	98.8	Hydrocel cup (sandwich UHMWPE with Biolox forte) Al-on-Al (Biolox forte) versus UHMWPE-on-Al (Biolox forte)	Implex, CeramTec	Multiple sites, multiple surgeons	Designer, University, and general	North America (U.S.)	
Schmidt,	60 (60)	59.4 (3.2)	62	NA	5.6 (5-7)	100	Unspecified cup with Al-	CeramTec	Single site,	Designer,	Europe	

2002							on-Al (Biolox Forte) <i>versus</i> UHMWPE-on-Al (Biolox Forte)		multiple surgeons	university	(Germany), Australia (New Zealand)
Schwammlein 2002, Pitto 2000, 2003, Orec 2005	50 (50)	NA	NA	100	2.0 (NA)	NA	Phönix cup with Al-on-Al (Biolox Forte) <i>versus</i> UHMWPE (Chirulen)-on-Al (Biolox Forte)	Ceramtec	Single site, single surgeons	Designer, university	Europe (Germany), Australia (New Zealand) January 1999 – December 2007
Vendittoli, 2005, 2007, 2013	140 (116)	55.8 (12.5, 23-70)	51	62	12.3 (9.0- 14.6)	88.6	Cerafit cup Al-on-Al <i>versus</i> unspecified (chirulen 1020) PE-on-stainless steel	Ceraver Osteal	Single site, multiple surgeons	General	North America (Canada)
Zerahn, 2011	188 (188)	66.2 (11.5, 25– 69)	63	NA	NA (4- NA)	50.5	Ringloc cup (sandwich UHMWPE and Biolox forte) Al-on-Al <i>versus</i> UHMWPE-on-Zi	Biomet Inc.	Single site, multiple surgeons	Designer, university	Europe (Denmark)
Zhou, 2006	61 (61)	67 (46-87)	47	100	NA (2- NA)	96.7	Reflection cup with Al-on- Al(unspecified) <i>versus</i> HXLPE-on-CoCr	Smith & Nephew	NA	University	Australia (Australia)/ Europe (Sweden)

NA = not available (not applicable or not provided), FHN = Femoral Head Necrosis

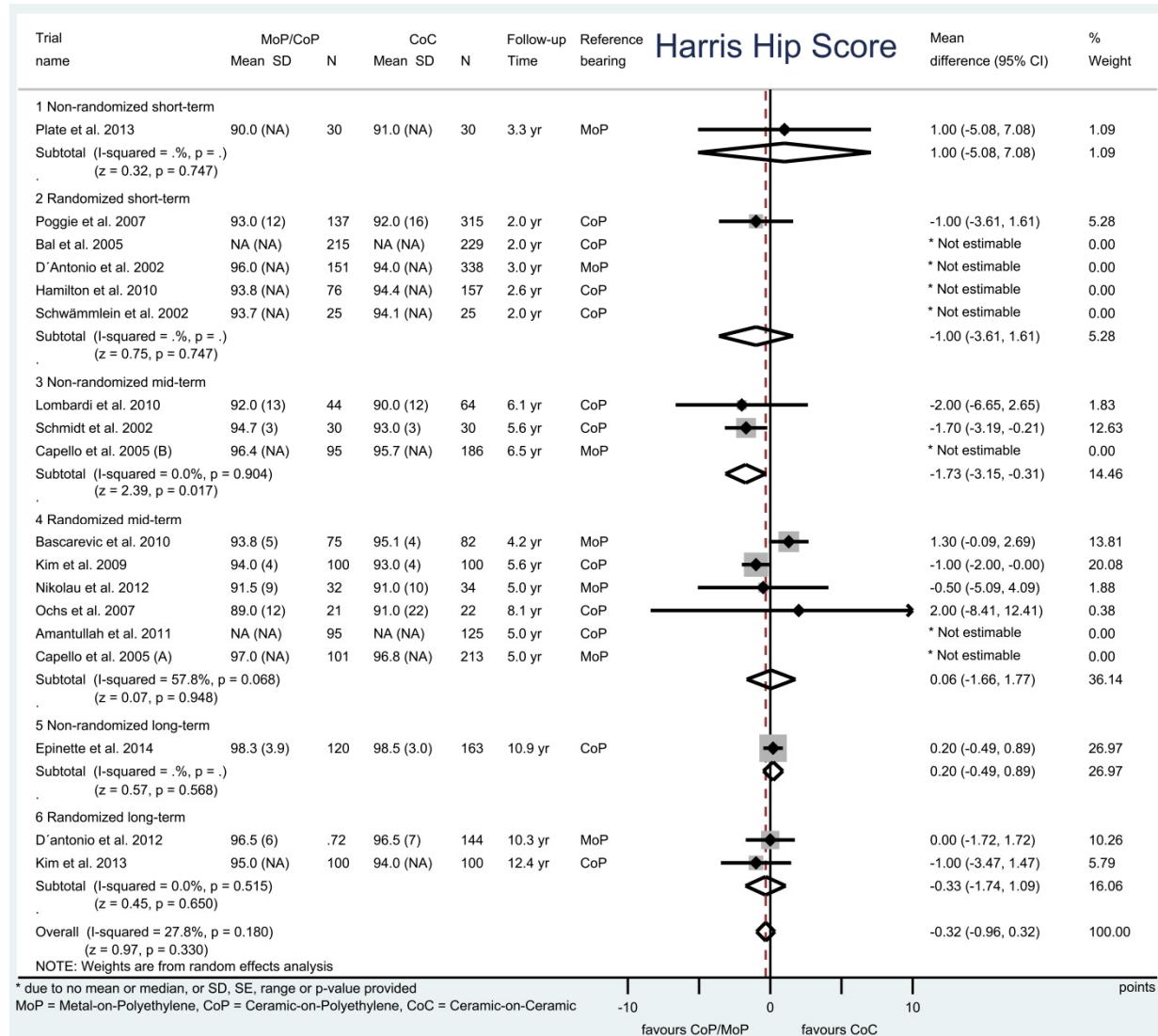
Al = Alumina, Zi = Zirconia, CoCr = Cobalt-Chromium, PE = PolyEthylene, HXLPE = Highly Cross-Linked PolyEthylene, UHMWPE = Ultra High Molecular Weight PolyEthylene* Data based on most recent reports

Hamilton, 2010	Moderate to high	Preoperative Postoperative	50.6 (NA) 94.4 (NA)	50.7 (NA) 93.8 (NA)	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- 0 (0%)	- 0 (0%)
Hernigou, 2013	Moderate	Preoperative Postoperative	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- NA	- NA
Kim, 2009, 2013	High	Preoperative Postoperative	38 (16-41) 94 (80-100)	37 (11-45) 95 (85-100)	NA NA	NA NA	62 (49-81) 12 (9-12)	63 (50-78) 11 (8-13)	NA NA	NA NA	- 3 (3%)	- 0 (0%)
Lewis, 2010	Moderate	Preoperative Postoperative	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- 0 (0%)	- 0 (0%)
Lombardi, 2010	Low to moderate	Preoperative Postoperative	51 (6-68) 90 (50-100)	48 (6-69) 92 (49-100)	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- 0 (0%)	- 0 (0%)
Milosev, 2012, Topolev, 2014	Low	Preoperative Postoperative	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- NA	- NA
Nikolaou, 2012	Moderate to high	Preoperative Postoperative	45.7 (23-90) 91.0 (61-100)	49.4 (22-90) 91.5 (63-100)	NA NA	NA NA	41 (6-75) 89 (35-100)	39 (10-89) 83 (44-100)	31 (21-51) 49 (24-59)	31 (15-48) 48 (14-65)	- 3 (8.2%)	- NA
Ochs, 2007	Moderate to high	Preoperative Postoperative	NA 91 (22)	NA 89 (12)	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- NA	- NA
Plate, 2013	Low	Preoperative Postoperative	49 (23-70) 91	48 (20-65) 90	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	- NA	- NA

				(54-100)	(50-100)						
Poggie, 2007	Low	Preoperative	45 (14-91)	43 (10-78)	NA	NA	NA	NA	Done but NA	Done but NA	-
		Postoperative	92 (36-100)	93 (51-100)	NA	NA	NA	NA	Done but NA	Done but NA	NA
Schmidt, 2002	Low to moderate	Preoperative	50 (46-66)	54 (47-70)	NA	NA	NA	NA	NA	NA	-
		Postoperative	93 (88-100)	95 (87-99)	NA	NA	NA	NA	NA	NA	NA
Schwammlein 2002, Pitto 2001, 2003, Orec 2005	Low to moderate	Preoperative	48.9 (NA)	47.7 (NA)	NA	NA	NA	NA	NA	NA	-
		Postoperative	94.1 (NA)	93.7 (NA)	NA	NA	NA	NA	NA	NA	NA
Vendittoli, 2005, 2007, 2013	Moderate	Preoperative	NA	NA	NA	NA	Done but NA	Done but NA	NA	NA	-
		Postoperative	NA	NA	NA	NA	10.7 (NA)	16.6 (NA)	NA	NA	0 (0%)
Zerahn, 2011	Low	Preoperative	NA	NA	36 (8)	40 (9)	NA	NA	NA	NA	-
		Postoperative	NA	NA	17 (7)	19 (8)	NA	NA	NA	NA	NA
Zhou, 2006	Low to moderate	Preoperative	NA	NA	NA	NA	51 (14-80)	48 (14-83)	28 (14-41)	26 (11-49)	-
		Postoperative	NA	NA	NA	NA	74 (37-100)	80 (37-100)	39 (18-56)	41 (18-58)	NA

NA = not available (not applicable or not provided), * significant difference * Data based on most recent reports

Forest plot for Harris Hip Score (in points) after short-term (2.0 – 3.3 years), mid-term (4.2 – 8.1 years) and long-term (10.3 – 12.4 years) follow-up



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